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SECTION D.

THE HELMINTH PARASITES OF MAN IN AUSTRALIA.

By T. HARVEY JOHNSTON, M.A., D.Sc., and
J. BURTON CLELAND, M.D., Ch.M.

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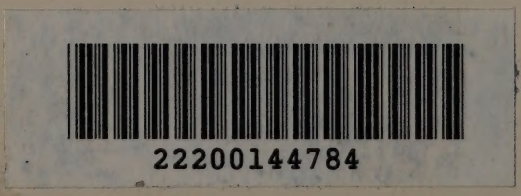
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11.—THE HELMINTH PARASITES OF MAN IN AUSTRALIA.

By T. HARVEY JOHNSTON, M.A., D.Sc., and J. BURTON CLELAND, M.D., Ch.M.
(From the Government Bureau of Microbiology, Sydney, New South Wales.)

In this note we endeavour to bring together the various references to the occurrence of the different helminths recorded from human beings in Australia. Though a goodly number have been identified, yet most of them are rare, while only a few are common. The main exceptions are the hydatid (the larval form of *Tænia echinococcus* v. Sieb. or, more correctly, *Echinococcus granulosus* Gmel.), *Oxyuris*, *Ankylostoma*, and *Filaria bancrofti*.

Hydatids are very frequently met with in man in every part of the Commonwealth. They are of such economic importance that we are reserving until a later date a survey of the literature referring to them. *Ankylostoma duodenale* Dubini, (—according to strict zoological nomenclature, perhaps more correctly known as *Agchylostoma duodenale*), the "hookworm," is restricted to the coastal districts of Queensland, where it is not uncommon. *Filaria bancrofti*, Cobbold, more usually known under the name of its larva, *Filaria* (*Microfilaria*) *nocturna* or *F. sanguinis hominis*, is now quite common in Queensland, and is also found, though much less frequently, in some of the other Australian States. *Oxyuris vermicularis* is here, as elsewhere, quite a common parasite of children. There have appeared recently some papers in which the majority of the references quoted below have been collected. The first was published by Dr. G. Sweet[1], followed very closely by another from one of us[2]. In addition to these two articles, more or less complete lists of our known endoparasites of man have also appeared[3], but these do not contain any references to literature, though a number of new records are established in them. However, all the above-mentioned papers refer to the zoological side of the matter.

The helminth parasites of man, as far as Australia is concerned, belong exclusively to the Trematoda, Cestoda and Nematoda.

Trematoda.—We may safely say that trematodes are practically absent in Australians. Three parasites belonging to this class have been recorded :—

1. FASCIOLA *hepatica*, Abildg, the common "liver fluke," found in sheep and cattle, has been found in man by Allen (Trans-Intercol. Med. Congr. Austr. II. 1899, p. 1004) on three occasions in five years in the Melbourne Hospital, seven worms being obtained in one case, and one in each of the others, abscesses being present in the liver of each patient. In addition to this reference there is another in the Austr. Med. Journ., IX., 1864, p. 29, where a letter from a Mr. Crawford of Swan Hill, Victoria, to a newspaper is quoted. In this letter he stated that the blacks of the Lower

(1) Sweet, *Proc. Roy. Soc. Vict.* XXI. (n.s.), 1908 (1909), p. 454 sqq.
(2) Johnston, *Rec. Austr. Museum*, VII., 1909, p. 329 sqq.
(3) Johnston, *Agric. Gaz. N.S. Wales*, XX., 1909, p. 581 sqq.
Austr. Med. Gaz., Sept., 1909, p. 479-481.
Ann. Rep. Bur. Microbiology, N.S. Wales, 1909 (1910), pp. 75-6.

Murray River were being exterminated by the flukeworm and tapeworm of the sheep. In the light of present knowledge of parasitology we think it advisable to disregard this latter reference entirely.

2. *Clonorchis sinensis* Cobbold, more commonly known as *Distomum sinense* or *Opisthorchis sinensis*, the Chinese fluke, has been found in Sydney and in Victoria in Chinamen, no cases being reported from Australians (Austr. Med. Jour., XVIII., 1873, p. 85 (Victoria); Jamieson, A.M.G., XVI., 1897, pp. 71, 147 (Sydney); Corlette, A. Med. Gaz., XVI., 1897, p. 146, 195 (Sydney).

3. *Schistosomum* (*Bilharzia*) *hæmatobium*, Bilharz. Several cases have been found in the Commonwealth, but in every instance the parasites had gained an entrance in South Africa. On the return of our troops from the South African War many were found to have become infected. The helminth appears to be able to live for many years, as we have quite recently found the ova in the urine of men who have been in Australia for a number of years since their stay in South Africa. The earliest record is that by Poulton (Austr. Med. Gaz. 1892, p. 347), the next being that by Seabrooke (A.M.G., 1893, p. 194), both of these being found in Adelaide in individuals who had resided in South Africa. Then follow a number of references mainly as a result of the return of infected soldiers (Hinder, A.M.G., XXIII., 1904, p. 511—Sydney; Stacy, A.M.G., XXV., 1906, pp. 350, 397—Sydney; Johnston, Proc. Linn. Soc., N.S. Wales, XXXIV., 1909, p. 118, and A.M.G., 1909, p. 480—Sydney;—Morton A.M.G., 1909, p. 79—N.S.W.). Newmarch (A.M.G., XXVI., 1907, p. 336; Inter. Med. Jour. Austr., 1907, p. 466), recorded finding one ovum of this blood fluke in Newcastle, N.S. Wales, in the urine of a patient who had not been out of Australia for 23 years. We agree with Nash (A.M.G., XXVI., 1907, p. 419) in regarding the record as invalid, being based on a mistaken identification. Another case is referred to by Dr. Tidswell in the Ann. Rep. Bur. Microbiology, N.S.W., 1909 (1910), p. 90.

Cestoda.—1. As already mentioned, tapeworms are quite rare in human beings in Australia, and as far as we can find out all those which have been acquired locally belong to the species *Tænia saginata* G., also known as *T. mediocanellata*, Kchm., the larva of which is *Cysticercus bovis*, a bladder worm producing measly beef. We do not know of any instances of the larva having been found in Australia, this indicating its extreme rarity, as it would be reported if met with during meat inspection. Of course it is quite possible that the cysticercus occurs in some country localities, more especially dairying districts, by infection from introduced cases in man, and might here be overlooked. It is in these districts where man and the ox are closely associated, whereas in the pastoral districts where cattle are raised for the meat market there is practically no such association. The recorded cases are as follows :—

Johnson, Trans. Inter. Med. Congr. Austr., 1905, p. 380 (Adelaide); Johnston, Proc. Linn. Soc., N.S. Wales, XXXIV., 1909,

p. 118 (Sydney), *ibid*, XXXV., 1910, p. 28 (Queensland), Jour. Proc. Roy. Soc. N.S. Wales, 1909, p. XX. (West Austr.), A.M.G., 1909, p. 480 (N.S.W.). In addition to these definite records there are a few others where mention is made of tapeworms, some of them of very considerable length, taken from human beings. They no doubt belong to this species (Flynn, A.M.G., 1901, p. 496—Q'land).

2. *Tænia solium* Linn., the armed cestode, is practically unknown, the only definite record being that by Johnston (Proc. Linn. Soc. N.S. Wales, xxiv, 1909, p. 118, N.S.W.), but as no history could be obtained it is not improbable that the patient had become infested elsewhere. This suggestion is supported by the fact that the larval or cystic stage, *Cysticercus cellulosæ*, which lives in the pig, has only once been reported from the Commonwealth (Johnston, Proc. Linn. Soc. N.S. Wales, 1909, p. 118), and moreover there is doubt as to the correct locality of the specimen. There are two other references to this parasite in man (Iffla, A.M.G., Melbourne, 1869—Victoria, and Anonymous, N.S. Wales, Med. Gaz. V. 1874-5, p. 57—N.S.W.), but both of these are more likely to refer to *T. saginata*.

3. *Dibothriocephalus latus* L. has once been reported, but very little is known of the history of the case, which was without doubt an imported one (Johnston, Proc. Linn. Soc. N.S. Wales, xxxiv, 1909, p. 118—Sydney). The larva of this parasite is known to infest various European fish

4. *Dibothriocephalus parvus* Stephens. This form was obtained by Dr. Elkington from a Syrian in Launceston, Tasmania, and like the last mentioned *Bothriocephalid* is also an importation from elsewhere. This parasite was considered as a new species by Stephens (Ann. Trop. Med. Parasitol., Feb., 1908).

5. In addition to the four above mentioned adult species, two larval forms have been recorded, one of them, the hydatid (*Echinococcus veterinorum* Rud., *E. hominis*, Rud., *E. polymorphus* Dies, etc.), being already briefly referred to. As stated previously, its importance medically is sufficient justification for it to be considered separately in a future communication.

6. The other is a larval Bothriocephalid, regarded as being identical with that described by Cobbold and Leuckart, and known variously as *Sparganum* (*Bothriocephalus, Ligula*) *Mansoni* Cobbold, and *B. liguloides* Leuckt. We think that the form in question may be similar to the Ligula-like larvæ found locally in lizards, snakes and frogs. It is probable that they are not specifically identical with Cobbold's species, but larval Bothriocephalid worms offer few points of specific value. All of these evidently occur only accidentally as human parasites. The one case was reported from Bathurst district, N.S. Wales, by Spencer (Trans. Inter. Med. Congr. Austr. III. 1892, p. 433), and the other by MacCormick and

Hill (Trans. Inter. Med. Congr. Austr. VII, 1905, pp. 367-8) in a patient from Sydney. In Spencer's case the worms were associated with abdominal tumours. In the latter case the patient had never lived out of Sydney.

7. A reference in A.M.G. 1891, p. 361, to a cystic disease of the liver resembling hydatids reminds one of *Cysticercus tenuicollis*, the " water-ball " found in sheep, cattle, and pigs.

8. Watson (A.M.G. 1906, p. 645) exhibited a large number of larval cestodes to illustrate a paper by him on hydatids, but there is no reason for incorporating them as records for Australia.

Nematoda.—The greater number of helminth parasites of man belong to the Nematodes, or roundworms. There appear to be seven which have established themselves in the Commonwealth, viz., *Ascaris lumbricoides*, *L. Oxyuris vermicularis* L., *Trichocephalus trichiurus* L. (*T. dispar* Rud.), *Filaria bancrofti* Cobbold, *Strongyloides intestinalis* Bavay, *Agchylostoma duodenale* Dub., and *Necator americanus* Stiles. In addition to these, a few others have been met with, but the source of infection has been traced to be beyond Australia. These include *Filaria medinensis*, *F. loa*, and *Trichinella spiralis*. *Filaria demarquayi* has been doubtfully recorded from New Guinea natives.

1. The commonest in Australia is the small threadworm or pinworm, *Oxyuris vermicularis* L., which occurs in all States. As it does not usually cause much trouble its presence has been practically unrecorded. Cobb, in 1890 (Proc. Linn. Soc. N.S.W., V, 1890, p, 168), dealt with its life-history. In 1901 R. H. Russell (Inter. Med. Jour. Austr., VI. 1901, p. 576) referred to a persistent appendicular colic caused by threadworms (Melbourne). Johnston mentioned the presence of this species in the various States (Proc. Linn. Soc. N.S. Wales, XXXIV, 1909, p. 119—N.S. Wales ; *ibid.* 1910, p. 28—Queensland-South Australia ; Jour. Proc. Roy. Soc., N.S.W., 1909, p. xx—West Australia).

2. *Ascaris lumbricoides*, L.—This intestinal parasite is found occasionally in man throughout Australia, but since it rarely gives rise to pathological conditions references in literature to its presence in Australia are very scanty. Morphologically it closely resembles, if it is not identical with, the roundworm, *Ascaris suilla*, of the pig. It is possible that if these species are identical infections of man may occur not infrequently from the pig, as for instance by means of the ova adhering to a sausage-skin derived from pig, and the ova not being killed by the cooking. Both the parasites have a peculiar sweetish smell, which is very characteristic and enables the species to be identified even in the dark.

The first reference to the presence of this worm in Australia occurs in a work entitled " Two Years in New South Wales "

(2nd edit., I, 1827, p. 172), by Surgeon P. Cunningham. He mentions the presence of " teres " or roundworms in the children in the settlement at Port Jackson. In 1897 Robison (Inter. Med. Jour. Austr., II, 1897, p. 87) reported a case of " Apical Pneumonia and Cerebral Symptoms associated with Worms " in a child of 4 years in Sydney ; 29 large roundworms were passed. In 1898 Springthorpe (Austr. Med. Gaz. 1898, p. 214) exhibited in Melbourne four roundworms which were passed dead during a typhoid fever attack, the patient giving a history of having vomited a roundworm 10 years before after a blow in the stomach. It would be interesting to know whether the death of these roundworms was due to the high temperature during the fever, to toxins produced by the typhoid bacilli, or to the altered condition of the intestinal contents. In the same year Lewers (Inter. Med. Jour. Austr., III, 1898, p. 534) reported the case of a Victorian girl of 17 years who had asthmatic-like attacks, and on the fifth night coughed or retched up a roundworm about 9 inches long. After this she felt great relief and had no further trouble. No more worms were passed, though suitable treatment was adopted.

In 1901 Flynn (Austr. Med. Gaz., 1901, p. 496) exhibited a roundworm from a Queensland patient, and in 1906 Ramsay (Austr. Med. Gaz., 1908, p. 468) showed a number vomited by a boy in Perth, West Australia, one being 9 inches long. Sweet (Proc. Roy. Soc. Vict., 1908, p. 515) mentioned its occurrence in Melbourne ; while Johnston (l.c. 1909 and 1910) referred to its presence in the various States.

Belonging to the *Trichotrachelidæ* are *Trichinella spiralis* and *Trichocephalus trichiurus.*

3. *Trichinella spiralis* Owen, more commonly known as *Trichina spiralis,* has been found in a few instances, but the disease Trichiniasis may be said not to exist in man or animals at the present time in Australia. We have ourselves examined portions of the muscles of pigs in West Australia, and of the rats *Mus decumanus* and *Mus alexandrinus* in Sydney, and have failed to detect the presence of any of these parasites, though in both sets of animals Sarcosporidia were met with in the muscle fibres. It is true that the number of animals thus examined was small, but did the disease exist it is almost certain that instances of it in human beings would from time to time present themselves clinically. With one exception (in some pigs from Richmond, N.S.W., many years ago) the few cases that have occurred have owed their origin to localities outside Australia. The first Australian instance on record of the disease in man occurred at Hobart in 1870 (Austr. Med. Jour., XV, 1870, p. 318), when the captain, two mates, the cook, and a young lady passenger on a German vessel in that port were infected in consequence of eating ham forming part of the provisions. In 1871 (Austr. Med. Gaz., XVI, 1871, p. 224) it is said that some pigs in Richmond, N.S.W., were found largely

affected with the trichina. In 1898 Dr. Halford (Austr. Med. Gaz., 1898, p. 263) read a note on and exhibited before the Queensland Branch of the British Medical Association specimens of this parasite, distributed throughout the muscular substance of a patient that had been operated on for epithelioma on the floor of the mouth. In 1902 Professor Watson, Dr. Angas Johnson, and Mr. Veterinary-Surgeon Desmond (A.M.G., 1902, pp. 106, 120 and 415, and Trans. Inter. Med. Congr. Austr., 1905, pp. 370, 380, S. Australia) reported a case whose nature was discovered during an operation for malignant growth in the neck. The disease was traced to infected meat received from outside Australia. Braun ("Animal Parasites," Engl., transl. 1906, p. 319) mentions its occurrence in man in Australia.

4. *Trichocephalus trichiurus* L., better known as *T. dispar* Rud., a parasite infesting the human cæcum, has been recorded on a few occasions from Queensland and New South Wales, but not as yet from any of the other States. There is little doubt that it occurs in them also. Hogg (Austr. Med. Gaz., VIII., 1888-9, p. 133) reported it from Queensland at the same time as he made known for the first time the existence of the hookworm in Australia. Bacot (A.M.G., XI., 1892, p. 430) also found both of these worms present at a post-mortem at Cairns, North Queensland. Bancroft in 1893 (A.M.G., 1893, p. 258) mentioned that this helminth was common in Brisbane. Lawes (A.M.G., XIV., 1895, p. 446) found it in company with Ankylostoma in 1895 while performing a post-mortem in Brisbane Hospital on a boy who had come from the Tweed Heads, New South Wales. Other references were made by Mollison in 1898 (Trans. Intercol. Med. Congr., 1898, p. 417, Queensland and N.S. Wales), and by Johnston in 1909 and 1910 (l.c. 1909, 1910, Queensland and N.S. Wales).

5. *Strongyloides intestinalis* Bavay, also known as *Anguillula* or *Rhabdonema stercoralis*, was found in Queensland in 1896 by Ashworth (Austr. Med. Gaz., XV., 1896, p. 483), in company with *Ankylostoma*. He did not identify it definitely, but there is no doubt but that this is the species referred to. Turner (A.M.G., 1896, p. 484) refers to Ashworth's find, and remarked that the worms were neither *Oxyuris* nor *Ankylostoma*.

Belonging to the *Strongylidae* in its wide sense are the two hookworms *Agchylostoma duodenale* and *Necator americanus*, both reported from Queensland. Besides these *Eustrongylus gigas* is said to have been found. The last mentioned was recorded by Allan (A.M.G., XVI., 1897, p. 607) as being passed with the urine by an old man. This is evidently a case of mistaken identity, as a glance at his account will show. It was almost certainly not a worm at all.

6. *Agchylostoma duodenale* Dubini. Undoubtedly the three most important human parasites in Australia are the hydatid, the

filaria *F. bancrofti*, and the hookworm. The latter is more commonly known as *Ankylostoma duodenale*, though it is spelt in more than a dozen different ways, *Agchylostoma* being the first used. Some workers now use the term *Ankylostoma* as a popular name for the parasite, but retain the original spelling when referring to the worm under its scientific name. We all know of its ravages in some parts of the world. It is becoming very widespread along the coastal districts of Queensland, especially in the rural districts, where there is a lack of sanitary conveniences, and where the children, who are the main sufferers, go barefoot. With a single exception all the cases come from the Northern State.

As already mentioned, Hogg was the first to find the hookworm in Australia (A.M.G., VIII., 1888-9, pp. 60, 92, 133, and Brit. Med. Jour., 1889, p. 792), obtaining it at Goonda Lunatic Asylum, Queensland. It is quite possible that the anæmia referred to by Ahearne (A.M.G., 1890, p. 293), as being present in the inhabitants of Townsville, was the result of infection by Ankylostomes, which had not at that time been detected in that part of Queensland.

In 1892 we find that Bacot (A.M.G., 1892, p. 450) and Gibson (*Ibid.* 440) refer to cases, the former finding it in three children from Cairns, the latter detecting it in an adult from Maryborough. There is also a reference by Gibson and Turner to its occurrence in North Queensland in the Trans. Inter. Med. Congr. Austr. 1892, p. 134. In the next year Dr. T. L. Bancroft exhibited specimens (A.M.G. 1893, p. 258) before the Queensland Branch of the British Medical Association. In 1895 several references occur. Turner, Gibson, Love and Ashworth (A.M.G., 1895, p. 456) all refer to it, Turner mentioning its occurrence in children in Brisbane and North Queensland; Gibson referring to his finding it in an adult; Love to its presence in a child of four years of age, from whose fæces Ashworth stated that he had obtained two hundred ankylostomes after Love had employed thymol. In the same year Lawes (A.M.G., 1895, pp. 445-8) published notes on two cases in children, one coming from the Tweed Heads, just within the New South Wales border, the other from Brisbane. Turner refers to it again in the Proc. Roy. Soc. Queensland, XI., 1895, p. 99.

In 1896 this parasite is again dealt with by Ashworth (A.M.G., 1896, pp. 482-4) and Turner (A.M.G., 1896, p. 484; Trans. Inter. Med. Congr. Austr. 1896, p. 101; and Inter. Med. Jour. Austr. I., 1896, p. 65). Ashworth mentions that he treated a child of ten years of age with thymol and picked out 650 hookworms from the first two succeeding stools. In addition to the ankylostomes, the *Rhabdonema* referred to above was also present (p. 483-4). Turner referred to Ashworth's case, making remarks on the *Rhabdonema*.

In 1897 Hardie (A.M.G., 1897, p. 354) found the parasite in an adult in Cairns. In the next year O'Doherty (A.M.G., 1898, p. 47) in a presidential address referred to the hookworm, and some of the earlier records to its presence in Queensland.

In 1902 T. L. Bancroft (A.M.G., 1902, p. 66) called attention to Looss's discovery of infection by Ankylostoma through the skin, and stated that cases which had occurred in two families at Deception Bay could be explained in a similar way, viz., by foot-infection. He referred to the lack of sanitary conveniences and to the want of covering on the feet of the children.

There do not appear to be any further references until 1906, when Hamilton-Kenny (A.M.G., 1906, p. 399) furnished notes on an outbreak in Gympie, where five cases were treated. Conditions similar to those mentioned by Bancroft were found in this locality also.

In 1908 Macdonald (Lancet, 11th Jan., 1908) referred to the prevalence of and effects due to *A. duodenale* in Northern Queensland, while O'Brien (A.M.G., 1908, p. 122) mentioned that it was quite common in Cairns district, remarking at the same time that he believed the hookworm in Australia to be different to the Old World parasite, *A. duodenale*, and the American hookworm *Necator americanus*.

In 1909 a fairly comprehensive paper by Salter appeared in the Aust. Med. Gaz., 1909, p. 352-6, abstracted in Inter. Med. Jour. Austr., 1909, p. 423. In this he gives the number of cases treated in Brisbane Hospital between 1900 and 1909, and mentioned infected localities. He quotes many of the earlier cases and refers to work in Porto Rico and elsewhere, making special reference to Looss's discovery. He emphasises the danger of coming into contact with contaminated surface-soil. In the paper (p. 355) he makes mention of Bancroft's finding of *Necator americanus* in Queensland. In the same year Turner (A.M.G., 1909, p. 351) called attention to the wide distribution of ankylostoma along the Queensland coast as well as the northern rivers of New South Wales. The fact that the infected children are generally barefoot and belong to homes where sanitary conveniences are lacking strongly supports Looss's view of skin-infection. Halford, Gibson, P. Bancroft and Robertson (A.M.G., 1909, p. 391) all briefly refer to the occurrence of this parasite in the northern State. Other references include those of Johnston (*loc. cit.* 1909, 1910). A few records of *A. duodenale* and *Necator americanus* are re-published in Jour. Trop. Med. Hyg. XII., 1909, p. 348.

From a consideration of the above it will be seen that the infected district is very extensive, that the infection is confined mainly to children who live in rural districts, who go barefoot and whose homes do not possess sanitary conveniences. The evidence also still further proves the value of thymol in cases of ankylostomiasis, a fact already well known from the report of the Porto Rico Commission.

7. *Necator Americanus* Stiles. The American hookworm was identified by Sandwith and Leiper in some material sent by Dr. T.

L. Bancroft (Brit. Med. Jour., Oct., 1908, p. 1354) from Queensland, Salter (A.M.G., 1909, p. 355) mentioning the fact in his paper on Ankylostoma (*vide supra*).

Filaria.—Belonging to the Filariidæ are a number of human parasites, one of which *F. bancrofti* Cobbold is frequently met with. Certain others have been reported, but in these cases infection had taken place beyond Australia.

8. *Filaria bancrofti* Cobbold.—This interesting and important helminth is very frequently called *F.* (*Microfilaria*) *nocturna* Manson and *F. sanguinis hominis* Lewis. It has a very wide geographical range, but it is only its Australian distribution which concerns us here. An account of the earlier work and workers may be found in Cobbold's "Parasites, A treatise on the Entozoa of Man and Animals," 1879, p. 186, sqq., and p. 487. The earliest reference to the presence of these microfilariæ in Australia was in Cobbold's papers published in 1876 in the Brit. Med. Jour. of June, and the Veterinarian of July of that year. In these he confirmed Dr. J. Bancroft's finding of the embryos in specimens of blood from a case of chyluria in Queensland, which the latter had forwarded to him. Cobbold then questions Bancroft's discovery of the adult filaria in lymphatic abscesses and in hydroceles in December, 1876, publishing, (p. 186-7), a letter written from Brisbane in April, 1877, by the latter informing Cobbold of his find. In the Lancet (July, 1877, p. 70) the worm was named *F. bancrofti*, and further particulars were given on p. 495. In 1878 Bancroft recorded in the Trans. Pathol. Soc. London, XXIX., p. 407, a number of cases of filariasis. Then followed other papers by Cobbold, Manson and others in the Lancet and Jour. Linn. Soc. Lond., in which references were made to Bancroft's work. Then Cobbold published a letter from Bancroft in the *Lancet* of February, 1879. The latter published further information in the A.M.G., 1882, p. 170, and the A.M. Jour. IV., 1882, p. 361, and the Trans. Intercol. Med. Congr. Austr., 1889, p. 49.

Love (A.M.G., 1889, p. 135) mentioned that he found embryo filariæ in the blood of a girl suffering from chylous urine. In 1890 Turner (A.M.G., 1890, p. 65) dealt with two cases, the subjects being Brisbane boys. In one instance there were well marked lymph swellings in the groin, in the other chyluria was present. In 1892 Hogg (A.M.G., 1892, p. 416) met with a case of elephantiasis of both legs, filariæ being present in the blood.

In the same year, in an article on Leprosy in Queensland, Dr. Joseph Bancroft (A.M.G., 1892, p. 427) made some very interesting remarks on the cases of filariasis that he had encountered. He took charge of the Brisbane Hospital as Resident Surgeon in 1868, and in reviewing the cases of leprosy he had met with during his sojourn in Brisbane since that time he states that his attention was turned from the few cases of leprosy to cases in which large elastic tumours, mostly of the groin, were found, and also cases of chyluria. Filaria were

found associated with both of these latter, and he became of opinion that both the leprosy and the filaria were associated diseases brought here by the Chinese, and distributed by mosquitoes. Numerous cases of filarial disease were found in the families of cottagers, who had wells, open water butts, and tanks, and in one instance there were four children suffering from filaria in one family. His researches led him to the more careful exclusion of mosquitoes from water tanks by gauze covers, and the disuse of wells, and he states that happily since the large water-works pipes were distributed so freely few young children were now found with manifestations of filarial diseases. He referred to his original paper published in the Pathological Society's Transac., 1878, vol. 29, p. 407, at which meeting he crossed swords with the President, Sir Erasmus Wilson, who called him to task for affirming that the term " Elephantiasis " should be used for the big leg disease only, and that " Elephantiasis græcorum " as applied to leprosy should be abandoned. On reading over the old case books of the Brisbane Hospital he became convinced that amongst its records there were cases of leprosy and possibly also of filarial diseases.

In a paper written in 1893 (A.M.G., 1893, p. 260) Dr. E. S. Jackson, of the Brisbane Hospital, states that he had seen 40 cases in two years, and had histories of recent experience of nearly 30 cases embracing most of the conditions which observers in other countries had attributed to filaria. The majority of his cases had enjoyed good health, even those who were subject to periodical attacks of the pyrexia which Faro has termed " elephantoid fever." Most of his cases were under 20 years of age, the oldest being 52 years. This latter case was the worst he had seen, for the patient had marked elpehantiasis in his leg and foot, and was subject to much erysipelas. The disease as he had seen it occurred only in the native born population or in people who had come to Queensland at an early age. He believed that the severer forms had not been found amongst aborigines, and surmised from that, that the disease had been introduced into this country from some other place. Most of the cases had come from places within thirty miles of Brisbane, one from New South Wales, and two from European countries. In several instances two or three people in one family were affected, which, he was led to believe, was a common experience. The duration of the disease was from one to twelve years, and he was inclined to think that one of the effects of the parasite was delayed menstruation in girls and the later arrival of puberty in boys.

In the discussion on this paper Dr. Marks referred to two patients suffering from this disease who died very suddenly, in his opinion, from cardiac embolism. Dr. Peter Bancroft was of opinion that, judging from the number of young children he saw whose blood contained filarial embryos, the disease was increasing in Brisbane, and referred to two patients in the Children's Hospital, Brisbane, suffering from popliteal abscesses, which were very

common things in children in Brisbane who harbour the parasite. Dr. T. L. Bancroft said he was of opinion that the filariæ were introduced from China and the South Sea Islands, and that the aborigines of Australia originally did not harbour the parasite. He stated that filariasis was endemic all along the coast.

Dr. T. L. Bancroft in 1893 (A.M.G., 1893, p. 258) exhibited specimens of Filariæ in blood and chylous urine, making references to the nocturnal appearance of the embryos.

In 1894 Drs. Peter Bancroft, E. S. Jackson, and T. L. Bancroft (A.M.G., 1894, p. 6) referred to a slight increase of the leucocytes in the blood of infected patients. They give the leucocyte counts of six cases. In three of them there were popliteal abscesses, and the leucocytes varied from 12,000 to 23,750 per c.mm.; in two other cases there were elephantiasis, and the leucocytes varied from 14,500 to 27,300. In the fifth case, about which no details are given, the leucocytes were 5500. No attempt was made to ascertain the type of leucocytes increased, but in such of the cases in which there was a marked increase in their number, either from abscesses or from elephantiasis, it is probable that the increase was chiefly in the polymorphonuclear leucocytes, thus indicating a bacterial invasion of some kind.

In 1898 (A.M.G., 1898, p. 271) appears a letter from T. L. Bancroft, in which he mentions that he has been able to record the metamorphosis of *Filaria sanguinis hominis* in the muscles of the thorax of two species of mosquito, viz., *Culex ciliaris* and *Culex vigilax*. Also that upon the death of the mosquito the young filariæ do not escape from its body into water and therein live a free life, but invariably die, and that those embryo filariæ which are destined to develop leave the stomach of the mosquito at an early date and take up their abode in the muscles of the thorax. He suggests that possibly human infection may result from swallowing mosquitoes which have imbibed filarial blood. Early in 1899 (A.M.G., 1899, p. 120) this author made another communication referring to his experiments on the transmission of filariæ by mosquitoes, in which he stated that he believed water to be the medium into which the embryos escaped after leaving the insect. A very important paper was published later in the same year (Jour. Proc. Roy. Soc. N.S. Wales, XXXIII., 1889, p. 48-62) by him. In it he deals with the metamorphosis of the young form of *F. bancrofti* in the body of *Culex ciliaris* L., the house mosquito of Australia. He induced the mosquitoes which he had bred out from larvæ to bite an infected Queensland girl, and was able to demonstrate the presence of actively moving embryos in the mosquito on the sixteenth or seventeenth day, but not before. If the weather were cold, this stage might be delayed till the twentieth day, or even the thirty-fifth day (p. 62). No further development of the embryo occurred even after a sojourn of sixty days in the body of the mosquito. He found that the young filariæ were usually present in the thorax, and occasionally in the abdomen.

There were usually three or four, but sometimes as many as twenty-five embryos in a filariated mosquito, whereas he did not find any embryos in his " control " insects. Since the larvæ died after three or four hours' immersion in water, he concluded that water could not be the medium by which the filariæ reached man after leaving the mosquito. He suggested that the latter would need to be swallowed (as does happen accidentally sometimes) by man for infection to occur. In an addendum (p. 62) he mentions that he also thinks that young filariæ may gain entrance to human beings when the mosquitoes bearing them are in the act of drawing blood, the warmth of which may stimulate the embryos to pierce the insect's œsophagus and to pass down the proboscis into the human skin. We know now that this latter suggestion regarding direct transmission from the mosquito is the correct one. *Culex notoscriptus* Skuse and *C. annulirostris* Skuse are given as additional hosts (p. 61). He thought it not unreasonable to suppose that since the larvæ were killed by water they would be probably killed by the human digestive juices.

In 1903 Dr. Flynn, of Ipswich, Queensland (A.M.G., 1903, p. 248), stated that he had had about 60 cases in the last five years. He suggested that the disease had been introduced from China or the Pacific Islands, and referred to the various clinical signs which his series of cases exhibited, such as elephantiasis, chyluria, lymphscrotum, chylous hydroceles, orchitis, etc. He referred to the typical pyrexial attacks in the elephantiasis cases. He mentioned the occurrence in chylous cases of rigors heralding the outbreak. In chyloceles he found the embryos present in numbers. He mentioned that an increase occurred in leucocytes in one of his patients at the approach of an attack of pyrexia.

In the same month Dr. T. L. Bancroft (A.M.G., 1903, p. 251) published a paper entitled " Notes on Filaria and Mosquitoes." Cosh and Sawkins (A.M.G., 1903, p. 214) both refer to the disease. Dr. Macdonald (A.M.G., 1905, p. 334) showed illustrations of a case of filarial elephantiasis of the scalp. O'Brien (A.M.G., 1908, p. 123) mentioned that filariasis existed sporadically in Northern Queensland.

In a paper on " The Manifestations of Filariasis as it appears in Queensland," Dr. E. S. Jackson (A.M.G., 1908, p. 344) was of opinion that the complaint was greatly on the increase in Brisbane. He stated that the disease had not been observed yet in the Tweed River district of New South Wales, which forms part of the boundary between Queensland and New South Wales. He had found it more commonly in the male sex and chiefly in the native-born population, or those who had come to Queensland in early childhood. The poorer classes were more subject to it. He also referred to the various lesions produced by the disease. In the discussion (p. 370) on this paper Dr. Maclean referred to the fact that he had examined the blood of all the patients of three wards in the hospital and had found filaria in from 15 to 18 per cent. of

them. Dr. Salter reported a case of chyluria which had recovered subsequently to an attack of typhoid fever; and Dr. Dodds mentioned a case in which cerebral symptoms intervened. Dr. Peter Bancroft related a case in which a number of adult worms were found in a tumour removed from the groin, and remarked that the death of a patient suffering from filariasis occurs sometimes immediately after the death of the worms.

In 1909 Maclean (A.M.G., 1909, p. 444) mentioned that out of 600 consecutive admissions to the Brisbane General Hospital 15 per cent. had filariae in the blood. In 1909 17 per cent. out of 200 cases were found to be affected, and a month later there were 16 per cent. In 1910 three articles appeared in the A.M.G. on the subject. Jackson's (A.M.G., 1910, p. 231) communication is mainly historical, and in it he gives a summary of earlier literature referring to the parasite in Queensland. P. Bancroft (p. 233) and Maclean (p. 234) published some notes on the disease. Other references to the occurrence of filariasis in Australia are as follow :—

Colledge, Proc. Roy. Soc. Q'land, XV, 1900, p. 127 (Queensland).

Bancroft, Jour. Trop. Med. Lond., 1899-1900, II, pp. 91, 149; 1901, p. 822 (Queensland).

Manson & Shipley, in Allbutt & Rolleston's Syst. Med., II, part ii, p. 933, 936 (Queensland).

Cleland, Jour. West. Austr. Nat. Hist. Soc., June, 1906 (Queensland—North-West Austr. ?); Jour. Trop. Med. Hyg., 1909, XII, p. 348 (Queensland); Bull. 7-9 Dept. State Med. & Publ. Health, West Austr., 1908, p. 22 (West Austr.).

Fülleborn & Rodenwaldt, " Filarien " in Real. Encyclopadie d. Gesamt Heilk., Aufl. 4, p. 55-64 (Queensland).

Blanchard, Arch d. Parasitol, III, 1900, p. 285 (Queensland).

Johnston, Agric. Gaz. N.S. Wales, XX, 1909, p. 583; Rec. Austr. Mus., VII, 1909, p. 336; A.M.G., 1909, p. 479 (Queensland, N.S.W., S. Australia, W. Australia).

Looss, in Mense's " Handb. d. Tropenkr.," I, 1905, p. 162.

Braun, " Animal Parasites of Man," 1906, pp. 289-291 (Queensland).

9. *Filaria medinensis* Velsch (=*Dracunculus medinensis*). The only instance in which this worm is recorded as having been found in Australia occurred in an officer on board a ship in Hobson's Bay in 1860. The case was reported by MacGillivray (A.M.J., Vol. 5, p. 172).

10. *Filaria loa* Guyot (=*Loa loa*). In 1874 Tassell (A.M.J., Vol. 19, 1874, p. 33) removed from the eye of a middle-aged man a worm about 1½ in. long, which he had seen wriggling over the

anterior surface of the sclerotic, beneath the conjunctiva. The patient could feel the animal moving about.

In 1898 Dr. Cherry (Inter. Med. Jour. Austr., III, 1898, p. 416) exhibited before the Medical Society of Victoria a worm about 2½ in. long, removed by Dr. Harris, of Rutherglen, from the subcutaneous tissues of the eyelid of a man who had been a missionary in tropical Africa. Dr. Barrett said it resembled in general appearance *Filaria oculi humani*, or *F. loa*. These two references are undoubtedly to *Filaria loa*, which is certainly an imported parasite.

11. *Microfilaria demarquayi* Manson ?. Manson ("Tropical Diseases," London, 1898, p. 446) regarded embryonic filariæ found in the blood of New Guinea natives as being probably the same as the above species, which is only found in the West Indies.

Braun ("Animal Parasites," 1906, p. 297) and Looss (Mense's "Handb. d. Tropenkr.," I, 1905, p, 169) mention Manson's reference. Fülleborn and Rodenwaldt ("Filarien" in Real. Encycl. d. Gesamt. Heilkunde Aufl. 4, Berlin, p. 79) regard the identification as doubtful.

Occasionally references occur in the literature to other parasites found in man in Australia. In 1897 Dr. Brummitt, of Adelaide, showed a worm 10 in. in length, very thin, white, and round, passed with the urine by a woman. (A.M.G., 1897, p. 135.) The nature of this organism seems quite uncertain, and it is possible that it may have been an adventitious addition to the urine. In 1902 Dr. Angas Johnson, of Adelaide, described a worm passed in the urine (A.M.G., 1902, p. 924).

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